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ANDERSON FILTER SUBSTRATE WEIGHT LOSS

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Southern Research Institute

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The report gives results of an investigation, under laboratory conditions, to determine the extent and cause of weight losses first noticed in field situations on Andersen impactor fiberglass substrates. The investigation results indicated that, if performed carefully throughout, sample acquisition should result in a weight loss of no more than 0.20 mg per stage. Such a loss is not of major consequence when more than 2-3 mg is collected on a stage; however, it could represent a serious error at less than 2-3 mg. Incomplete drying and careless handling were found to be the major sources of weight loss.

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ANDERSEN FILTER SUBSTRATE WEIGHT LOSS

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ANDERSEN FILTER SUBSTRATE WEIGHT LOSS STUDY

This study was undertaken to determine if weight losses from the fiber filter substrates of the Andersen Impactor were significant and to what extent they might affect field test measurements. A procedure was set up to check for errors in the mechanics of the weighing, moisture absorption by the substrates, errors due to handling, and errors resulting from running an impactor. These will be explained in detail later.

The filter substrates for the Andersen Impactors, with the exception of the back-up filters, were baked for approximately 18 hrs in an oven at a temperature of 240°C. The back-up filters were baked for about 6 hrs at the same temperature. The substrates were from normal Andersen substrate stock. The back-up filters were cut from glass fiber filter stock. Mine Safety Appliance No. CT-75428.

After all substrates and filters had been baked, they were allowed to cool to ambient temperature in room air. They then were left sitting out for 4 days at room temperature and humidity while their foil holders were cut. After being folded and placed in the foil holders, the substrates, including foil holder, were weighed. The process of placing the substrates in the foils and then weighing them took 2 days, making a total of 6 days elapsed time from the baking procedure. All substrates were then placed in desiccators.

The balance used in the study was a Cahn Model G-2 Electrobalance. The total weight of the substrates and foils was greater than 200 mg but this scale was used with counterweights (tare weights) for improved accuracy. To keep moisture at a minimum, the weighing chamber was loaded with

a small pan containing Drierite, anhydrous $CaSO_4$. This is our normal procedure in weighing Andersen substrates.

The average weights for the Andersen glass fiber substrates and back-up filters were also measured so that the weight losses could be evaluated relative to this total weight. Due to the design of the Andersen Impactor, the filter substrates alternate in pattern from stage 1 to stage 8; stage filters being alike for stages 1, 3, 5, and 7, but different for stages 2, 4, 6, and 8. To obtain an average weight, 50 substrate filters of the odd type (1, 3, 5, 7), 50 of the even type (2, 4, 6, 8), and 50 back-up filters were baked at 240°C for 6 hours, desiccated for 18 hours, and then weighed on a Mettler Gram-atic balance. The average weights are:

Odd Filter Stage Substrates (1, 3, 5, 7)	189.54 mg average,
Even Filter Stage Substrates (2, 4, 6, 8)	178.92 mg average, &
Back-up Filter	215.04 mg average.

Weighing-Balance Errors and Moisture Absorption Errors

Three sets of the substrates, Nos. 13N, 15N, and 16N, were used to check the possibility of errors being made just in the process of weighing the substrates. Also, this was a check on the reproducibility of the balance in weighing an object. In addition to sets 13N, 15N, and 16N, two stainless steel ferrules and one flat washer were included in the weighing as standards, since these should neither lose nor gain significant mass due to absorption. They were cleaned in benzene to remove any grease and kept in clean containers in a desiccator throughout the test. Tweezers were always used in handling the ferrules, the washer, and the foil-wrapped substrates.

The results of the ferrule and washer weighings are given in Table 1. Approximately one weighing of each was made each

Table 1. Steel Ferrule and Washer Weight Changes Upon Desiccation

	Initial Weight, mg	Cumulative Hours of Desiccation									
		6	24	30	48	54	72	78	96	120	144
A	494.12	+.02	.00	+.02	.00	+.02	.02	.00	.00	+.02	+.02
B	422.50	.00	.02	.00	.00	.00	.02	.02	+.02	.02	.00
C	413.80	.00	.02	.02	.00	.02	+.02	.02	+.02	.02	+.02

Weight change in mg as compared to initial weight after indicated number of hours of desiccation.

A & B are stainless steel Swagelok ferrules; C is a zinc-plated steel washer.

All weight changes are negative unless otherwise noted.

day during the study. (All weights in all tables are negative except those preceded by a + sign). The two ferrules were made of 316 stainless steel and are listed as "A" and "B" in the table. The washer was made of zinc-plated steel and is listed as "C". The true weight of A, B, and C can be derived since the tare weight used with the Cahn balance was weighed also. Its weight was 366.7 mg, as weighed on a Mettler Gram-atic balance.

$$\text{True weight} = [\text{Cahn reading} \times 200 + 366.7]\ \text{mg}$$

The "Cahn reading" is the reading taken from the mass dial as a fraction of full scale, which is unity; 200 is the range multiplier; and 366.7 is the tare weight correction. Using a mass reading of 0.4321 as an example:

$$[0.4321 \times 200 + 366.7]\ \text{mg} = 453.1\ \text{mg}$$

True weights were not generally calculated because weight losses could be monitored by differences of direct readings on the Cahn.

The substrate sets 13N, 15N, and 16N were the control group of substrates. They were weighed periodically while the other tests were being conducted. They served as a check on desiccation losses, balance calibration, and zero shift. These sets remained wrapped in their foil covers throughout the tests to avoid any loss of the filter material. The results of weighing these sets are shown in Table 2. The amount of desiccation prior to each weighing is indicated in the table.

The table is structured as it is because Andersen substrates are of two types, varying between even and odd impactor plates.

Table 2. Andersen Substrate Cumulative Weight Changes Due to Desiccation (Sets 13N, 15N, 16N)

	Initial	Desiccation Period 6 hrs	24 hrs	48 hrs	72 hrs	96 hrs	120 hrs
Odd Numbered Stage Substrates:							
Average	-	0.12 mg	0.15	0.14	0.14	0.15	0.15
σ	-	0.03 mg	0.03	0.02	0.03	0.02	0.02
No. of Filters	-	12	12	12	12	12	12
Even Numbered Stage Substrates:							
Average	-	0.12 mg	0.15	0.14	0.14	0.15	0.16
σ	-	0.04	0.03	0.02	0.02	0.03	0.02
No. of Filters	-	12	12	12	12	12	12
Back-Up Filters:							
Average	-	0.05 mg	0.09	0.09	0.09	0.07	0.10
σ	-	(0.01 mg)	(0.03)	(0.02)	(0.01)	(0.02)	(0.03)
No. of Filters	-	3	3	3	3	3	3

Cumulative weight change as compared to initial weight after indicated number of hours of desiccation.

All weight changes are negative unless otherwise noted.

Parentheses indicate loss of accuracy due to insufficient data.

The substrates are cut to fit the impactor plate without obstructing the jets. Any difference in surface area of the filter might cause a different evaporation amount. The back-up filter is also separated from the even and odd substrates.

Table 3 gives the raw data for each set of substrates by stage. Table 4 indicates the moisture pickup of substrates which had been baked and desiccated as previously described. Three back-up filters were used, and instead of Drierite, a container of water was placed in the balance weighing chamber to give maximum humidity. Before the test, the balance was zeroed and calibrated.

Handling Losses

Handling losses in this case mean losses occurring in the process of loading and unloading an impactor. The substrates were taken from the foil covers and loaded into an impactor just as if it were about to be run; but immediately after assembling it, the impactor was unloaded and the substrates placed in the foil covers.

Six sets of substrates were used. Three sets (10N, 11N, 12N) were treated entirely as typical substrates for a normal run. The other three were cleaned. Each filter substrate was carefully checked for loose fiber pieces, which were removed, and then each filter was blown off with dustless freon. These were designated as the "clean" substrates (7N, 8N, 9N).

All six sets were desiccated for 48 hrs, weighed, loaded into impactors, unloaded, and then placed in the desiccator for 48 additional hours.

During the unloading process, the jet plates were brushed down to remove any bits of fiber which remained on them. Any

Table 3. Cumulative Changes in Weight Due to Desiccation of Andersen Substrates by Individual Set

		Cumulative Desiccation Period					
		6 hrs	24 hrs	48 hrs	72 hrs	96 hrs	120 hrs
Set 13N							
	1	0.10 mg	0.15 mg	0.12 mg	0.10 mg	0.12 mg	0.14 mg
	2	0.04	0.12	0.10	0.12	0.10	0.14
	3	0.10	0.12	0.12	0.14	0.12	0.14
	4	0.08	0.16	0.14	0.14	0.16	0.16
	5	0.10	0.16	0.18	0.18	0.18	0.20
	6	0.10	0.16	0.16	0.16	0.18	0.18
	7	0.08	0.12	0.14	0.14	0.12	0.14
	8	0.10	0.12	0.12	0.12	0.10	0.14
	F	0.06	0.08	0.10	0.08	0.10	0.12
Set 15N							
	1	0.16	0.16	0.14	0.14	0.16	0.16
	2	0.14	0.16	0.14	0.16	0.18	0.18
	3	0.10	0.12	0.12	0.10	0.12	0.12
	4	0.14	0.14	0.14	0.12	0.14	0.14
	5	0.16	0.16	0.18	0.16	0.16	0.18
	6	0.14	0.12	0.12	0.12	0.12	0.14
	7	0.16	0.16	0.14	0.14	0.12	0.16
	8	0.14	0.14	0.16	0.14	0.16	0.16
	F	0.06	0.06	0.06	0.08	0.06	0.06
Set 16N							
	1	0.14	0.20	0.14	0.14	0.16	0.16
	2	0.16	0.20	0.18	0.18	0.18	0.20
	3	0.12	0.18	0.16	0.14	0.18	0.16
	4	0.16	0.18	0.16	0.16	0.18	0.16
	5	0.14	0.20	0.18	0.18	0.16	0.12
	6	0.10	0.10	0.12	0.10	0.12	0.12
	7	0.10	0.14	0.12	0.12	0.16	0.14
	8	0.08	0.18	0.12	0.12	0.16	0.14
	F	0.04	0.12	0.10	0.10	0.06	0.12

All weight changes are negative unless otherwise noted.

Table 4. Moisture Absorption by 3 Andersen Back-Up Filters

Elapsed Time (min)	Cumulative Weight Changes, mg		
	#1	#2	#3
0	-	-	-
5	+.10	+.08	+.08
10	+.10	+.08	+.08
15	+.12	+.12	+.14
20	+.12	+.12	+.14
25	+.12	+.12	+.14
30	+.12	+.12	+.14

loose fiber was placed with the substrate nearest it. Sets 9N and 11N which were loaded into Andersen No.507 showed signs of the substrates being partially cut through by the metal o-rings. These two sets were the only ones with noticeable pieces of fiber left on the jet stages, which were brushed onto corresponding substrates.

Table 5 gives average losses of the cleaned-up substrates. Table 6 gives the same for the normal substrates. Tables 7 and 8 give individual stage losses for all six sets.

Running Losses

Six sets were used for determination of weight change while sampling filtered air. They were treated as normal substrates in loading them into the foil covers. No special cleaning of the filters was done. All sets were desiccated for 48 hours.

Three of the sets (4N, 5N, 6N) were loaded into impactors after desiccation and the impactors were run at 0.5 acfm for 6 hrs at room temperature, 24° C. A Gelman 47-mm filter holder and filter were attached to the inlet of the impactors to insure that clean air was sampled.

The other three sets (1N, 2N, 3N) were set up in the same way and run at 0.5 acfm for 6 hrs in an oven at 120°C.

When these sets of substrates were unloaded, the same brushing technique as described above was used. The substrates from the impactors run at room temperature were similar to those that had just been loaded and unloaded. The Andersen No. 507 impactor showed slight gasket cuts on several of the substrates. Andersens No. 229 and 231 had no cut substrates, but were crimped as required for a good seal.

Table 5. Desiccation and Handling Weight Change of "Clean" Andersen Substrates (7N, 8N, 9N)

Desiccation Weight Change	Average	σ	Number in Average
Odd numbered substrates	0.02 mg	0.06 mg	12
Even numbered substrates	0.10	0.04	12
Back-up filters	+0.01	(0.05)	3
Handling Weight Change			
Odd numbered substrates	0.06 mg	0.04 mg	12
Even numbered substrates	0.09	0.04	12
Back-up filters	0.04	(0.06)	3
Handling Weight Change by Stage			
Stage			
1	0.03 mg	(0.04) mg	3
2	0.08	(0.02)	3
3	0.05	(0.02)	3
4	0.09	(0.03)	3
5	0.09	(0.05)	3
6	0.11	(0.01)	3
7	0.07	(0.03)	3
8	0.08	(0.05)	3
F	0.04	(0.06)	3

Numbers in parentheses indicate insufficient data for accurate σ.

All weight changes are negative unless otherwise noted.

Table 6. Desiccation and Handling Weight Change of "Normal" Andersen Substrates (10N, 11N, 12N)

Desiccation Weight Change	Average	σ	Number in Average
Odd numbered substrates	0.02	0.04	12
Even numbered substrates	0.00	0.03	12
Back-up filters	0.08	(0.07)	3
Handling Weight Change			
Odd numbered substrates	0.06	0.06	12
Even numbered substrates	0.04	0.04	12
Back-up filters	+0.01	(0.08)	3
Handling Weight Change by Stage			
Stage			
1	0.10	(0.05)	3
2	0.07	(0.05)	3
3	0.08	(0.02)	3
4	0.05	(0.07)	3
5	0.01	(0.02)	3
6	0.01	(0.02)	3
7	0.03	(0.08)	3
8	0.03	(0.02)	3
F	+0.01	(0.08)	3

Numbers in parentheses indicate insufficient data for accurate σ.

All weight changes are negative unless otherwise noted.

Table 7. Desiccation and Handling Weight Change of "Clean" Andersen Substrates by Set

	Weight Change During Desiccation	Weight Change After Impactor Loading
Set 7N Andersen 229		
1	0.12 mg	0.00 mg
2	0.18	0.06
3	0.02	0.04
4	0.16	0.01
5	0.02	0.08
6	0.08	0.12
7	0.02	0.04
8	0.14	0.04
F	0.04	+0.02
Set 8N Andersen 231		
1	0.06	0.08
2	0.10	0.10
3	0.04	0.04
4	0.12	0.12
5	0.00	0.14
6	0.06	0.12
7	0.06	0.06
8	0.06	0.06
F	+0.02	0.04
Set 9N Andersen 507		
1	+0.04	0.02
2	0.06	0.08
3	0.00	0.08
4	0.06	0.14
5	+0.02	0.04
6	0.10	0.10
7	+0.10	0.10
8	0.04	0.14
F	+0.06	0.10

All weight changes are negative unless other noted.

Table 8. Desiccation and Handling Weight Changes of "Normal" Andersen Substrates by Set

	Weight Change During Desiccation	Weight Change After Impactor Loading
Set 10N Andersen 229		
1	0.00 mg	0.12 mg
2	+0.04	0.12
3	0.02	0.10
4	0.00	0.12
5	+0.02	0.04
6	+0.06	0.04
7	+0.06	0.12
8	+0.02	0.06
F	0.00	0.08
Set 11N Andersen 507		
1	0.04 mg	0.14 mg
2	+0.02	0.04
3	0.00	0.08
4	0.00	0.04
5	0.04	0.00
6	0.02	0.00
7	0.00	0.02
8	0.04	0.02
F	0.10	+0.06
Set 12N Andersen 231		
1	0.10 mg	0.04 mg
2	0.02	0.04
3	0.04	0.06
4	0.02	+0.02
5	0.02	0.00
6	0.02	0.00
7	0.02	+0.04
8	0.00	0.02
F	0.14	+0.04

All weight changes are negative unless otherwise noted.

The substrates run at 120°C showed more cutting. Again, Andersen No. 507 had substrates which were cut by the seals but slightly more severely. There were more pieces of fiber on the jet stage than previously. Substrates from Andersens No. 229 and 231 this time showed slight cuts in some of the stages. This may have been due to heating the impactor, or possibly to overtightening of the impactors, although an attempt was made to tighten them equally each time.

After sampling filtered air for 6 hrs, each set was unloaded, brushed, foiled, and desiccated for 48 hours before weighing. The results are shown in Tables 9-12.

Miscellaneous

In Table 13, the results of two blank sets of substrates loaded normally and run under stack sampling conditions at an aluminum reduction plant with a Gelman filter in front of the impactor, are given. The stack temperature was 125°F and the running times are listed in the table. Also shown is the average of a blank set run at a hot side precipitator on a coal-fired boiler.

For comparison and to gauge the significance of impactor weight losses, Table 14 includes some averages of typical Andersen Impactor stage net weight changes, including possible filter weight loss, observed in sampling several types of industrial particulate sources.

Also investigated was the possibility of using Teflon filter membranes as substrates. The type of Teflon filter used was

Table 9. Desiccation and Sampling Weight Change of Andersen Substrates (4N, 5N, 6N) after Sampling Filtered Air at 0.5 acfm for 6 hours at 24°C

Weight Change During Desiccation	Average	σ	Number in Average
Odd numbered substrates	0.16 mg	0.05	12
Even numbered substrates	0.14	0.03	12
Back-up filters	0.17	(0.03)	3
Weight Changes Due to Sampling			
Substrates 1-4 average	0.06 mg	0.03	12
Substrates 5-8 average	0.07	0.03	12
Odd numbered substrates	0.07	0.03	12
Even numbered substrates	0.06	0.02	12
Back-up filters	+0.03	(0.03)	3
Sampling Weight Change by Stage			
Stage			
1	0.08 mg	(0.02)	3
2	0.06	(0.02)	3
3	0.05	(0.05)	3
4	0.05	(0.03)	3
5	0.06	(0.02)	3
6	0.06	(0.02)	3
7	0.07	(0.03)	3
8	0.07	(0.03)	3
F	+0.03	(0.03)	3

All weight changes are negative unless otherwise noted.

Parentheses indicate loss of accuracy due to insufficient data.

Table 10. Desiccation and Sampling Weight Change of Andersen Substrates (1N, 2N, 3N) after Sampling Filtered Air at 0.5 acfm for 6 Hours at 120°C

Weight Change During Desiccation	Average	σ	Number in Average
Odd numbered substrates	0.14 mg	0.04	12
Even numbered substrates	0.15	0.05	12
Back-up filters	0.15	(0.06)	3
Weight Change Due to Sampling			
Substrates 1-4 average	0.15	0.04	12
Substrates 5-8	0.17	0.04	12
Odd numbered substrates	0.17	0.04	12
Even numbered substrates	0.15	0.04	12
Back-up filters	+0.03	(0.08)	3
Sampling Weight Change by Stage			
Stage			
1	0.15	(0.01)	3
2	0.11	(0.02)	3
3	0.17	(0.04)	3
4	0.13	(0.02)	3
5	0.14	(0.00)	3
6	0.17	(0.02)	3
7	0.19	(0.06)	3
8	0.19	(0.01)	3
F	+0.03	(0.08)	3

All weight changes are negative unless otherwise noted.

Parentheses indicate loss of accuracy due to insufficient data.

Table 11. Desiccation and Sampling Weight Changes of Andersen Substrates by Set after Sampling Filtered Air at 0.5 acfm for 6 Hours at 24°C

	Weight Change During Desiccation	Weight Change Due to Sampling
Set 4N Andersen 229		
1	0.20 mg	0.08 mg
2	0.12	0.04
3	0.16	0.08
4	0.16	0.06
5	0.08	0.08
6	0.08	0.08
7	0.04	0.12
8	0.12	0.08
F	0.14	0.00
Set 5N Andersen 231		
1	0.22 mg	0.06 mg
2	0.12	0.08
3	0.18	0.00
4	0.16	0.02
5	0.18	0.06
6	0.12	0.06
7	0.18	0.08
8	0.18	0.10
F	0.20	+0.04
Set 6N Andersen 507		
1	0.20 mg	0.10 mg
2	0.18	0.06
3	0.18	0.08
4	0.16	0.08
5	0.12	0.04
6	0.12	0.04
7	0.18	0.10
8	0.14	0.04
F	0.18	+0.06

All weight changes are negative unless otherwise noted.

Table 12. Desiccation and Sampling Weight Changes of Andersen Substrates by Set after Sampling Filtered Air at 0.5 acfm for 6 Hours at 120°C

	Weight Change During Desiccation	Weight Change Due to Sampling
Set 1N Andersen 229		
1	0.14 mg	0.16 mg
2	0.12	0.10
3	0.12	0.16
4	0.18	0.10
5	0.16	0.14
6	0.16	0.14
7	0.14	0.24
8	0.14	0.18
F	0.10	+0.06
Set 2N Andersen 231		
1	0.10 mg	0.14 mg
2	0.10	0.14
3	0.06	0.14
4	0.12	0.14
5	0.16	0.14
6	0.10	0.18
7	0.08	0.12
8	0.10	0.18
F	0.12	+0.10
Set 3N Andersen 507		
1	0.16 mg	0.20 mg
2	0.20	0.10
3	0.16	0.22
4	0.20	0.14
5	0.18	0.14
6	0.22	0.18
7	0.22	0.22
8	0.20	2.20
F	0.22	0.06

All weight changes are negative unless otherwise noted.

Table 13. Weight Changes of Andersen Substrate after Sampling Filtered Effluent from a Wet Precipitator at an Aluminum Reduction Plant. 125°F Gas Temperature

Stage	Sampling Time 240 min.	103 min.
1	-	-
2	+0.06 mg	+0.02 mg
3	0.04	0.04
4	0.02	+0.04
5	+0.08	0.04
6	0.12	0.16
7	0.08	0.10
8	0.12	0.10
average	0.04 mg	

All weight changes are negative unless otherwise noted.

Average weight change of Andersen substrates after sampling filtered effluent from a hot side precipitator on a coal fired boiler.

Temperature = 635°F Sampling Time = 90 min. Average = 0.02 mg

Table 14. Typical Average Amounts of Collection for an Andersen Impactor

Stage	Site and Amount in mg						
	A	B	C	D	E	F	G
1	1.13	0.37	1.70	15.79	0.59	6.74	9.70
2	0.78	0.27	1.29	6.94	0.39	2.45	6.97
3	0.84	0.30	1.08	11.62	0.35	2.08	8.23
4	0.80	0.28	1.17	7.23	0.34	1.63	8.93
5	0.95	0.32	2.12	8.73	0.25	2.52	12.62
6	1.25	0.29	4.96	5.56	0.48	5.30	14.48
7	1.84	1.10	5.06	2.99	1.08	4.99	8.61
8	2.72	1.68	2.64	0.66	1.00	2.52	4.39
F	22.40	4.51	5.53	3.85	3.91	3.01	8.56
Sampling Time (min).	431	921	210	38	371	140	255
Stack Temp. (^{o}C)	121	41	335	166	66	152	167

A. Wet scrubber at submerged arc ferro-alloy furnace.
B. Wet precipitator on aluminum reduction pot lines.
C. Hot side precipitator on coal fired boiler.
D. Precipitator on coal fired boiler.
E. Wet scrubber on open hearth furnace.
F. Pilot scale precipitator on coal fired boiler.
G. Precipitator on coal fired boiler.

Chemware filter membranes made of Zitex, which is a fibrous, porous form of pure TFE-Teflon/Halon. They are produced by Chemplast, Incorporated. A 75-mm, extra fine filter was used. It was desiccated without being wrapped with anything and weighed at various intervals. Then, it was baked for 6 hrs at 205°C and weighed again, desiccated for 24 hrs, and weighed one final time. The baking appeared to cause no damage to the filter. Results are given in Table 15.

CONCLUSIONS

Several conclusions can be drawn from this study of Andersen filter substrates:

1. From Table 1 it can be seen that the Cahn Model G-2 Electrobalance used in this study as well as our normal laboratory and field test work is quite stable in day-to-day operation. Repetitive weighings of metal objects agreed within 0.02 mg over a six day period. This degree of uncertainty represents a very small percentage of normal stage weights (e.g., Table 14).

2. Tables 2 and 3 indicate that the substrates lose about .10-.20 mg of absorbed moisture when desiccated for 24 hours at room temperature. Although further desiccation does not remove additional moisture, losses do occur when clean air is pulled through the impactors. These losses are approximately .05-.10 mg for six hours testing at 0.5 acfm at room temperature (24°C), and .10-.20 mg at elevated temperatures (120°C). These results are summarized in Tables 9, 10, 11, and 12. Although a definitive reason for this has not been

Table 15. Cumulative Weight Change of Teflon Filter Substrate after Desiccation and Baking

Original weight - 509.08 mg

Hours of Desiccation	
24	-0.04 mg
48	-0.04
72	-0.04
96	-0.02
After baking 6 hrs at 205°C	-0.26
After 24 hrs desiccation	-0.22

established, one possibility is that the moving air dries the substrates more than normal desiccation. This explanation is consistent with the larger losses which occur when clean, hot air is drawn through the impactors.

3. Table 4 confirms the reabsorption of water vapor by previously desiccated substrates upon exposure to a humid atmosphere. Within ½ hour, the weight lost during a desiccation period of 24 hours is regained (∿.10-.20 mg). For this reason, the substrates and stage catches from impactor tests should be desiccated for at least 24 hours before weighing, and the weighing should be done immediately upon removing each substrate from the desiccator.

4. Tables 5, 6, 7, and 8 indicate that if careful attention is maintained in weighing, loading, and unloading substrates, then the handling losses are not significantly better if the substrates are "cleaned" before use. Poor handling and impactor cleaning techniques would, of course, tend to magnify these errors.

5. The field test data shown in Tables 13 and 14 indicate that weight losses which may occur during impactor measurements can amount to more than 50% of the particulate catch for any given stage, but more often are less than 20%. The errors are most significant when sampling sources with extremely low grain loadings under circumstances that do not permit extended sampling times.

6. The data tabulated in Table 15 shows that the weight losses as indicated in Tables 9 and 10 can be either significant or insignificant depending on the amount of particulate collected per stage. Partial compensation for this weight loss could be obtained by adding approximately 0.1 mg per stage.

7. Although the weight losses were progressively higher for impactor loading and unloading, sampling clean cool air, and sampling clean warm air respectively, it was not proven whether the losses were due to drying, to loss of filter material, or both. One can generalize all the results, including field tests, as indicating that with prebaking, 24 hour desiccation, careful weighing and loading, careful unloading and impactor cleaning, post test desiccation for 24 hours, and careful final weighing, the weight losses can be minimized, and will probably be less than .20 mg per stage. This may or may not seriously degrade the accuracy of the particle size measurements, depending upon the amount of material collected. It would be desirable to collect 2-3 mg of material on every substrate, but this could result in excessively long sampling times at some locations, or overloading of other stages for some particle size distributions.